Menlo Park Notebook #39 [N-79-11-21]

This notebook covers the period November 1879-July 1880. Most of the entries are by Francis Upton and relate to electric lighting. There are also notes and drawings by Charles Batchelor on the telephone. The Upton material includes notes, calculations, and drawings of meter tests; tests of bast fibre and other carbon filament lamps; tests of a small motor; and calculations on boilers. The label on the front cover is marked "Meters &c." The book contains 282 numbered pages.

Blank pages not filmed: 4-7, 10-23, 210-211, 250-251, 254-255, 258-259, 262-263, 266-267, 270-271.

No 39
Results Times p 212
Times turned p 214

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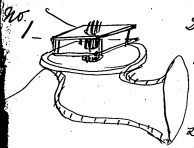
639

Results of experiments tried on Bartelot's telephone.

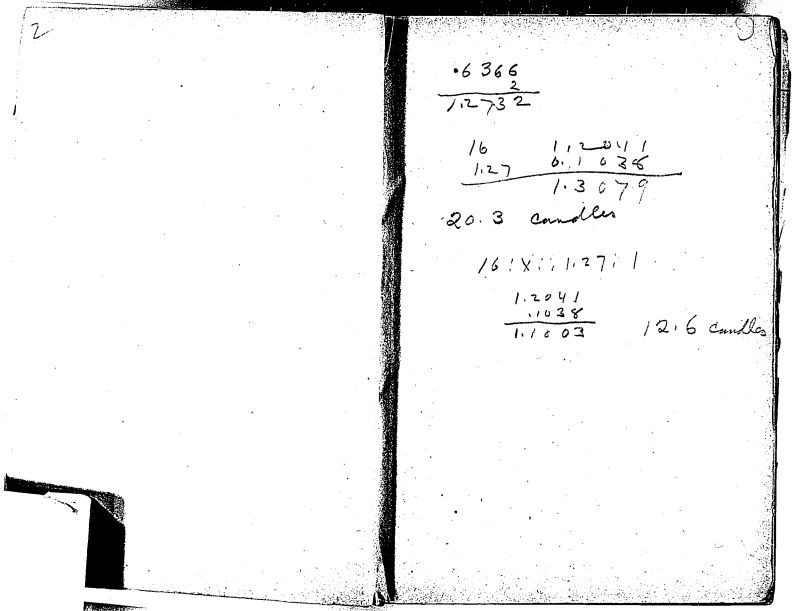
No. 1



Tried this with 66 pins — Articulation not good enough — Lessened the pins to 33 and this made the articulation worse Lessened them to 20 — Worse yet think if we made 500 we should have it perfect

Nov. 21st 1879 Charles Batchelor

Carl Rowland
Battery Jims
Hughes



2

•6366
2
1.2732

16 1.2041
1.27 0.1038
1.3079

20.3 candles

16 : X :: 1.27 : 1

1.2041
.1038
1.1603

12.6 candles

Lawson placed 16 plates 264 hours in a solution of 15 Cu SO_4 and 1 H_2SO_4, irregular amounts of solution used.

Plate 56	Surface	Loss
	16 sq. in	131 mg
	15	116
Both sides of plate	14	112
	13	106
	12	114
	9	87
	6	62
	5	51
	4	37
	3	41
	2	23
	1	20
	10.0	90.0

9 mg. per sq. inch loss in 264 hours

Loss per sq. inch per hour

9	01.9542
264	2.4216
	2.5326

.0.34 mg per hour per sq. inch

Four other plates without apparent reason but by another law

Surface	Loss
11	164
10	152
8	137
7	132
46	585 (127

46 | 585 (127
46
125
92
330

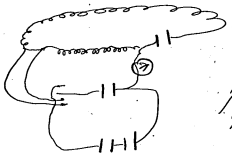
100 900
416 585
146 1485

3.1643
2.1613
1.0030
2.1216
3.1514

all the plates combined
.038 mg. per hour

Experiments with meters

Measure the polarization when a full current is passed through by means of the opposition method



Batteries Nov June 8 33

1	259 L	261 R
2	259 L	261 R
3	259 L	261
4	259 L	261 R
5	259 L	

5	59.5 L	60 R
+ 4	119 L	120 R
+ 3	179.75 L	179.75 R
+ 2	239	240
+ 1	299	301

1.09
4.32

3

June 8

31.1 Ohms in resistance box Temp. 68.67

This is the lower box for use in plating experiments

4 cells of Daniells

332 L 335 R

1-55 P.M. Started

2-00 144 L 145 R

around 31.1 Ohms

6.5 L 6.5 R around 5-9 Lawrence

2-07 146.5 L 145 R

2-10 145.5 145 R

2-15 146 L 145 R

4 cells

332.5 L 335 R

June 8

2-20 136 L 145 R

225 Stopped

Temp. 69.5 ~ 7 of falling

Plates No 9 Lawsons

5 0.583 grammes 9 grains

5 7.73 grammes 11.3 grains

10 8.313

Last Wt Book 48 page 266

5 7.740 grammes

5 0.650

Plates 8 5 6.335

Before 5 5.175

after 5 6 grammes 5 grains

5 5.972 15

not enough

38

$\frac{297}{101} \times 1.08 \times 20 =$ Volts

1.08
20
21.6 — 1.3345
2589 — 0.4609
1.7954
62.4 / 31.2 — 1.4955 — Taken this day
.2999
2

1.3757 | 2.1387
comp 35 | 8.4559
9.7001
1.2943

2 Webers
19.7 mgs. per minute

Stopped 4-17

---

101 | 290 | 19
2900

8 Volts / 35 — June 8 — 39

20 cells 100

3-42 O.M. Started

290 L — 290 R
287 L

20 cells
100 L — 101 R

293 L
290 R

Coil heated about 10° F

293 L
290 R
290 R
292 L

293 L
290 R
295 L
290 R

R 290
L 295

56.9315
55.595
1.3365
2.42
1.361
1.359
.2750
1.375

56.324
54.907
1.414
25
1.389

64,000 Ohms in line with galvanometer

104 on 9.03 Ohms
5 on meter

Lawrence Electric Before Bookstaber 266

(10) after 56.9315 — 55.595
54.259 — 55.735
111.1905 — 111.1250
.0595 — 111.1905
.0247

(8) 54.907 — 56.324
56.4617 — 55.097
111.3687 — 111.421
111.368
.0533
25

42

163
52
215 2.
1.4
2.29 2 Volts
20 | 11.4
5.7

52
5.7
46.3

210.5
71
781.5
16
40 | 29.15
7.44

71
7.44
6356

68.5 : 210.5 :: 46.3 :

2.3042
1.8356
8.1978
2.1676 146

71 : 210.5 :: 52 : 185

52 1.7160
210.5 2.3042
8.1487
185 2.2689

June 5 43

One cell of battery [illegible]
through 1.01 Ohms
and cell

216 ~~#~~ around 1.01
67 around cell

2 cells

~~146~~
163 around 1.01
52 around cell

1 cell

210.5 around 101
71 around cell

830 mg

4Ω | 83Ω
20.75

1.3170
0104
20.2 mg 1.3066

141.5
139
280.5

2Ω | 28Ω.

209. comp 14 8.8539
205
414 1.079 0.0330
414 2.6170
higher Temp. comp 31.15 8.5065
.0104

209
25 C
122

1 Weber 20.2 mg per minute
resistance of coil taken as 31.15Ω
Page 38
2 Webers 19.7 mg per minute
resistance of coil taken as 31.3 Ohms

June 9 1880

20 cells
141.5 L cells 139 R
10-6 Started
210 L 207 R
20 cells 31.1 Ohms
141 L 139 R
10-10
209 L 207 R
10-20 210 R
10-25 210 L
10-45 208 L 201 R
10-46 Stopped

(8)

55.737
34.907
.830

55.632
111369
111.3687
.0003

56.6407
55.737
.7247

(10)

56.9315
55.089
.8425

56.097
111.1816
111.1805
.0045

55.089
54.259
830

Plates 9 were in the circuit with a taller battery six hours

(9)

63.777

44.599
108,376
108.313
.063

Loss

page 47

June 9, 1880

If less deflection ~~was~~ obtained by any cause at galva. than expected, Ratings

or absolute value taken as too small, too little work done. Probably. Or Profs Ayrton & Perry took absolute ~~is~~ too small

63.5 deposited by one Weber

58

19 Webers

200
198
199

Webers	19	1.2788
	199	2.2959
		2.9799

.095 ,1 cell
.190 Webers
61 1.7853
26.7 1.4099
.3754

Ratio 2.37

June 9, 1880.

4 Plates 2 7/16 X 4"

5% Lawson's solution

Bichromate Kll 208 = D
198 R

10 Ohms in circuit

Resistance 10 Ohm

Battery poles 192 R
194 L

Galva. around 1 Ohm
100 to a Volt
20.5 L
17 R

Zero made good 18 R
20 L

Galva shunt = ∞
62 L
60 R

32

.26 Weber

26.5 1.4232
198. 7.7033
2 0.3010
9.4275 — 8.0042

85.75 1.9332
33.5 1.5250
.4082

Ratio 2.56

June 9. 1880.

33

Around Circuit

Shunt ∞ 24.5 R
24.5
27
51.5
25.75 27 L
24.5 R

7 Ohms beside meter in circuit

Shunt ∞
around deposition.
32 R
35 L 33.5

Around 1 Ohm
Shunt ∞ 85 R
86.5 L 85.75

Shunt 28 L
100 Volt 25 R 26.5

54 .42 Weber

41.75 1.6206
8.0043
9.6249

137.5 2.1383
49.75 1.6968
.4415

Ratio 2.76

Bichromate June 9 1880 17

195 R
195 L

4 Ohms in circuit besides deposition

Around 1 Ohm

43 L
40.5 R

43
40.5
835
41.75

Shunt ∞ 136 R
139 L
137.5

Around deposition cell

Shunt ∞ 51 L
48.5 R
995
49.75

199.5 2.3000
58.75 1.7689
Ratio 340 .5311

1 Ohms 9 inches per cell

Around depositing cell

Shunt ∞ 118 R
120 L

Around 1 Ohm

New Shunt 199 R
200 L

Around deposition cell

New Shunt 60 L
57.5 R
117.5
58.75

.1925 Webers

June 9

Meter on shunt

Shunt .114 Ohms

Wire 4.1 Ohms

Bichromate cell

200 L 200 R

Around 1 Ohm

21 L 17.5 R

17.5

38.5

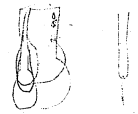
19.25

30.25 : 296.5 :: .114

T. 0569
2. 4720
8. 5193
0.0482

1.111 Ohms in boxes if shunt has .114 Ohms

29.75 : 297 dc



June 9

Deflection around one Ohm made

294 L 300 R
292 L 293
586
2965

around shunt A

32.5 L 28 R
32.5 L 32.5
65
3025

Around the Ohm

3 P.M. 296 L 298 R

around Shunt A

31 L 28.5 R

31
28.5
59.5
29.75

Shunt B around A

43 L 40 R

around B

22 L 18.5 R

all shaken no difference

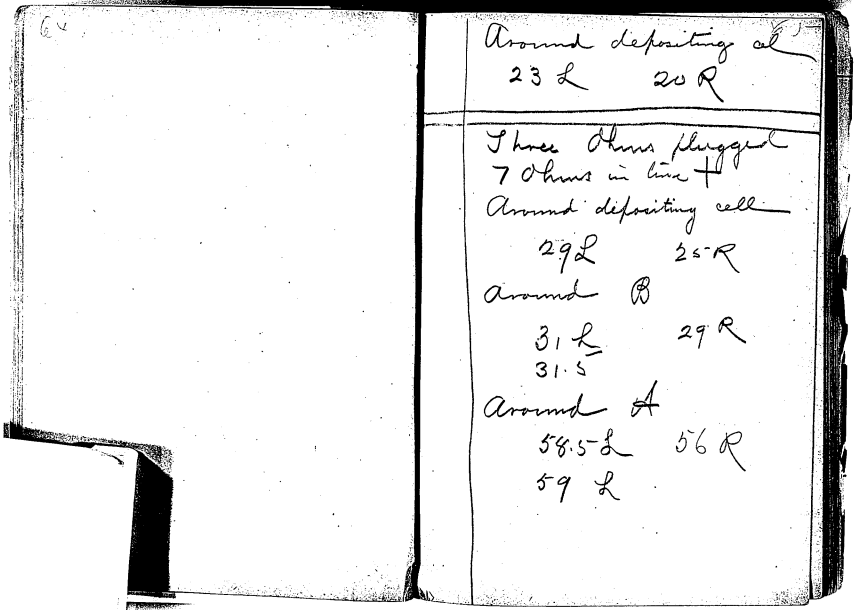
12

3-9 June 9 Around deposition cell ES
16 L 15 R
Around shunt A
44 L 40 R
Around B
25 L 20 R
Around deposition cell
22 L
23 L 20 R

3-17 Around A
43 L 40 R

3-22 43 L
Around B

3-24 25 L 19 R



Around depositing cell
23 L 20 R

Three Ohms plugged
7 Ohms in line +
Around depositing cell
29 L 25 R
Around B
31 L
31.5 29 R
Around A
58.5 L 56 R
59 L

another 3 Ohm plug

4 Ohms +

3-35 around A

96 L 96 R

Around B

61 L 60 R

Around depositing cell

34 L 32 R

3-38 3 Ohm across

~~7 Ohms +~~

3-39 29 L ~~27 R~~

around shunt A

59 L 56 R

4 Ohms
Around A

95.5 L 95 R

Around B

63 L 59.5 R

Around depositing cell

3-45 34 L 32 R

Battery

197 L 198 R

3-49 Around 1 Ohm

56 L 45 R

46 L

195 L

3-55 196 L

3-57 198.5 L 199.5 R

June 9 1880

Around one Ohm before making connection

4 –	46.5 L	43.5 R
	Around the shunt A	
4-4	96 L	94 R
	Around B	
	60 L	60 R
	around cell	
	36 L	34 R
	12 L from cell current broken as this is E. M. F of cell	
4-10	P&S R.	
	11.5 L	8.5 R

4 Ohms June 9 1880

Around cell

29 L 34 R
37 L
38

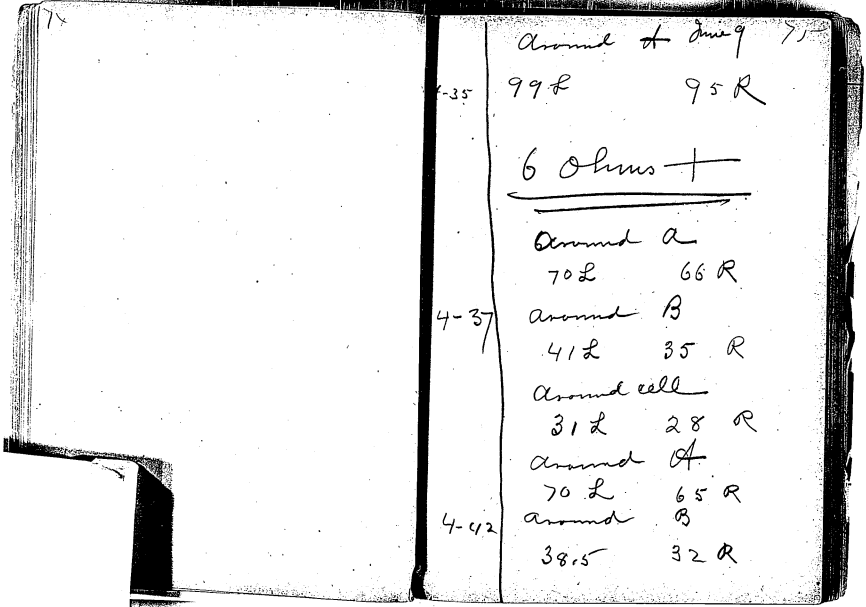
Circuit broken

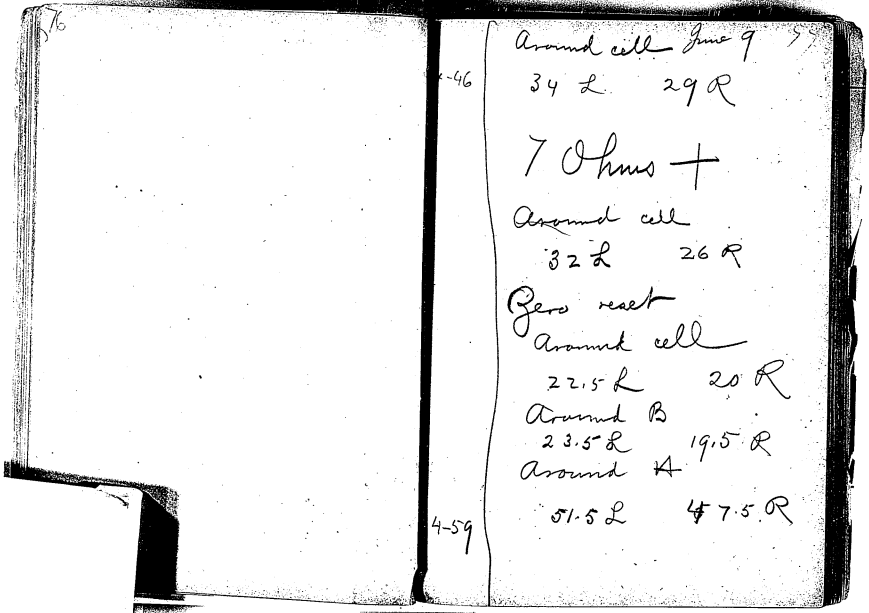
immediately	20 L
	15 L
15 sec	14 R
30	12 L
1 min	9 R
2 m	12 L
4 m	10

36 L 35 R
37 L

Around B

430 61.5 L 59 R


around A
99 L 95 R
6 Ohms +
around a
70 L 66 R
around B
41 L 35 R
around cell
31 L 28 R
around A
70 L 65 R
around B
38.5 32 R


76
Around cell June 9 57
4-46
34 L 29 R
7 Ohms +
Around cell
32 L 26 R
Zero reset
Around cell
22.5 L 20 R
Around B
23.5 L 19.5 R
Around A
51.5 L 47.5 R
4-59

Around R June 9 1880

25 L 20 R

Around cell

29 L 23 R

Reversed poles of battery

After one minute around the cell

20 L 18 R

Around B

36 L 38 R

Around A

55 L 54 R

Around cell

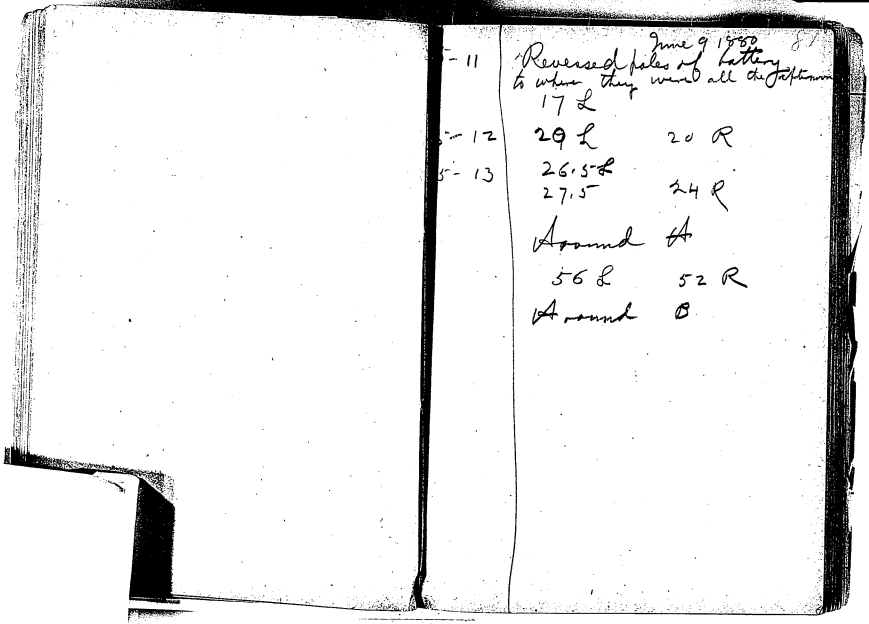
24 R 21 R

3 Ohm plug left in

30 L

Taken out 24 L 22 R

5-7



- 11
- 12
- 13

June 9 1588

Reversed poles of battery
to where they were all the afternoon

17 L

29 L 20 R

26.5 L
27.5 24 R

Around A

56 L 52 R

Around B

~~I wall~~

Boxes wound with German silver
Fitted with two cells in multiple
are run up the scale of
current with a depositing cell
direct in the current
From ratio make out resistance
and E.M.F. of cell

Run up a cell on a
shunt and down in-
creasing and decreasing the
current gradually but always
in same way to imitate
practice

Temp German silver coils
66.5 F
Resistance 31.10 Ohms

9-15 1 Weber of current
9-20 31.15 Ohms
2 Webers 31.3 Ohms
9-35 3 Webers 31.5 Ohms
4 Webers 31.7 Ohms
Temp thermometer laying on coils 80° F
coils warm to the hand

June 10

Cooling of coil

9.47	31.77 R
9.475	31.3 R
9.48	31.3 R
9.485	31.25 R
9.49	31.22 R

3 Ohm box wound with German silver wire
8.8 Ohms

2.1384
192 to a Volt

30 1.47711
amp 192 7.7167
amp 1.08 9.9666
1.1604 — 7.6833 — .744 Weber

447 2.65033
383 2.58332
.0671 — 1.17 Ratio
2
2.34

Shunt W 192 to a Volt with weight arm.

Shunt X $\frac{585}{40}$ X 192 = 2810 to a Volt

2.7672
2.2833
8.3979
3.4484

Shunt X
2810 X 1.08 = Deflection for one Weber
around B

3.4484 = 3030
0.633X
3.4818

June 10

Test of Electromotive force of depositing cells.

Bichromate
187 L — 200 R
188.5 L — 195 R
190 L — 194 R
190 L — 194 R

Bichromate circuit open
2-10 190 L — 194 R — 190 / 194 / 384
12 ohms in 1 unit
around
Shunt X
B 1.08 Ohm
Weber
A deposition
16 L — 13 R

40 1.6021
7.6833
9.2854 .193 Webers

585 2.7672
467 2.6693
.0979 1.25 Ratio
2
2.50

447 2.6503
3020 3.4818
9.1685 .197 Webers

383 2.5832
2810 3.4484
9.1348 .186
.068

585 2.7672
2.4818
9.2854 .193 Webers

467 2.6693
3.4484
9.2209 .166
.083 Volts

Around B June 10 57

15 R 15 R
15 L 14 R

Shunt X
made around B

222 L 225 R
222
447

Around A

189 L 194 R
184
383

9 Ohms in circuit

Shunt X
Around A

233 L 235 R
232
Around B 467

290 L 295 R
290
585

55.5 1.7443
7.6833
9.4276. .267 Weber

306 2.4857
221 2.3444
.1413 1.39/2 Ratio
2.78

305/55.5 X192
1.4800
2.2833
8.2557
3.0790 1045 to a Volt
10 61 page 96
2106
1053 to a Volt

360 2.5563
Comp. 306 7.5143
.267 9.4276
9.4982 .315 Webers

360 2.5563
259 2.413 7
.1430 259 2.413
3.022
9.3905
1.39/2 (246 .122
2.78

306 2.4857
1053 3.0225
.290 Volts 9.4632
.264 Volts 8.0334
9.4228 2.9891

221 2.3444
3.0225
9.3219
.1210
.105 Volts

Shunt W around 10 B
21 L 19 R 40
6 Ohms + in line

Shunt W
2-31 29 L 26.5 R
29
555

Shunt Y 15-5 L 15-1 R 155/155/306
Around coil A
111 L 110 R 111/110/221
5 Ohms in line

Shunt-Y
2-40 131 L 128 R
13
Around B259
181 L 180 R
179 R 360

96

417 2.6201
comp 360 7.4437
9.4982
9.5620 .365

417 2.6201
290 2.4624
.1577 1.44 Ratio
2
2.88

2.4624
3.0225
9.4309
30.10
9.1299 .134 volts

435 2.6385
comp 417 7.3798
9.5620
9.5804 .381

comp 306 9.4276
7.5143
435 2.6385
9.5804

435 2.6385
299 2.4757
.1628 1.45
2
2.90

97

2-45 4½ Ohms gmx 40
around B
206 L 211 R
206
417
around A
146 L 145 R
145 R
290

4 Ohms +
around A
150 L 150 R
148.5
150
149
299

2-50 around B
215 L 220 R
435

6 Ohm +
around B
152 L 150 R
around A
116 L 115 R

96

page 99

2 | 264.5

192.2

107 2.0294
192.2 2.2833
108 7.7167
9.9666
9.7127 .516

295.5 2.4705
192 2.2833
1.872 1.872

154
2
.308

Shunt Y 591/107 X 192 1061 to Volt

2.7716
2.2833
7.9706
3.0255

.133 2.1239
107 7.9706
9.7127
.9807 2 .642

2.7658
108 0.0334
2.7324
2.6117
.8783

404 2.6064
251.5 2.4005
.2059

1.60
2
3,20

Shunt Z 404/1332 X 192

2.6064
2.2833
7.8761
2.7558

3.7 Volt

Shunt Y 30 hms + gnd to around cell

192 L 192 R

192
384

Around B

294 L

297 R

591

S. Shunt W

3 — 57 L 50 R 50/57/107

2' Ohms +

70 L 63 R 133

Shunt Z around B

206 L 202 R

208 L 202 R 202/207/409

Around A

130 L 121 R

122 R

130
121.5
251.5

505
404 6442
160
.1802 Webers

505 2.7033
310 2.4983
.2250

1.652
.3376

210.5 2.3232
192.2 7.7162
10.8 9.9666
.0061 1.101

370 2.5682
210.5 2.3232
.2450 1.76
3.52

1½ Ohms + around A — June 10

152 L — 158.5 R
152
310

Around B

255 L — 250 R
235
505

1 Ohms +

325.5 L — 327 R
325.5
652.5

Shunt W

110 L — 102 R
109 L — 100 R
101
109.5
210.5

Shunt 3 400 Ohms around A

188 L — 182 R
188
370

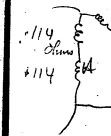
Zero 6 L

Cell

Shunt W

195 L — 189 R
194 L — 191 R
190
194.5
384.5

2 Shunts and cell



3-40 Bichromate cell

191 L 190 R

192 L

190
191.5
381.5

12 Ohms in line

3-5-5 192 L

No diffection from cells direct on galva-

Around 1 Ohm

20 L 10 R

On shunt

5 L

7 7.2 R

114
114
·228

1525 : 710 :: ·228 : x

2·85 13
1·35 79
7·81 67
0·02 59

1.06 Ohms

New Shunt around A

80 L 72 R 80.5 / 72 / 152.5
81 L

around B

51.5 L 43 R

around C

36 L / 87.5 26 R / 69

around A

83 L 75 R

9 Ohms in line A

105 L 100 R
99 R

12 Ohms in circuit

around 1.05 Ohms

360 L 360 R / 350 / 710

9 Ohms June 10 10

4-10

Around B

69 L 63 R

70 L

Around C

41 L 34 R

Around A

105 L 102 R

6 Ohms + Around A

4-10

149 L 149 R

149 R

Around B

107 L 102 R

Around C

47 L 45 R

104:482::228

7.3579
2.6830
7.9830
1.0239

1.05 Ohms

4 Ohms

Shunts around C

56 L 55 R

around B

171 L 172 R

around A

215 L 215 R

New Shunt around A

53 L 51 R

around 1.008 ohms

240 L 240 R 240
239 L 243 R 242
482

Shunt W 47 L 41 R

46 L 41 R

4-45 around battery circuit broken

190 L 190 R

165

3 Ohms + June 10 1909

Battery

306 L 308 R

On 1.08 Ohms

89 L 85 R

Shunt ∞

On Shunt A

4.55

272 L 271 R

on B

212 L 210 R

on C

66 L 62.5 R

2 Ohm +

on C

78 L 75. R

on A

off L R

on B

325 L 325 R

116

1 ohm June 10

Shunt 3000 on A

310 L 320 R

on B

272 L 275 R

on C

5-7 48 L 42 R

42 R

1.15 ohm

B. A. Resistance Coil

Shunt galva = ∞

1 Ohm
179 R
184 L
367

2 Ohms
355 L
352 R
707

367
2
734

2 Ohms
352 R
350 L
702

10-12

188 L
175 R
363

240 Ohms in circuit with [illegible] battery

June 11

1 Ohm	14 R 27 L 41		
2 Ohms	46 L 32 R 78	78 41 37	
3 Ohms	51 R 65 L 116	116 78 38	
4 Ohms	82 L 70 R 152	152 116 36	
5 Ohms	87 R 99 L 186	186 152 34	
6 Ohms	119 L 105 R 224	224 186 38	
7 Ohms	125 R 137 L 262	262 224 38	

10-20

8 Ohms
155 L
140 R
295

295
262
33

1 Ohm
15 R
28 L
43

9 Ohms
171 L
160 R
331

331
295
36

10 Ohms
178 R
188 L
366

366
331
35

10 Ohms in one plug
188 L
178
366

37

8 Ohms
150 R
148 L
298

10-40

10 Ohms
185 L
182 R
367

118

354.7 2.5498
349 2.5428
.0070

101.5 ohms

20 ohms in circuit 2 wire "15.

10-42

1 Ohm in box

178 L	175 L
169 R	165 R
347	350

The deflection around the multiple arc of three boxes

175 R	180 L
180 L	175 R
355	355

Temp 72° F

1 Ohm in resistance box

175 R	349
175 L	
350	

Om multiple arc

172
172
354

706 : 155 :: 1.0 : P

.0070
2.1903
7.1512
9.3985 comp Log 515

.223
.1115

155 2.1903

page 124 comp

155 2.1903

comp
Volt
at extremities

8.3 .9191
4.7924

to give Meters
and B

Comp .666 1.8195

Shunt ratio
1/87.4

.9085
1.9414

Bichromate 2 one "cell open
2 Volts

315 R
300 L

615
1 Volt = 307.5

12 Ohms + in circuit
On 1 Ohm +

19 R
30 L

Shunt = ∞ assumed Galva.

11-7

352 L
354 R
706

Page 101 See for diagram

On A	78 L		153
	75 R		157
	153		310
On B	32 R		155
	35 L		90
	67	67	65
		65	
On C	42 R	66	67
	48 L		90
	90		157

1.2 215 2.3385
Comp 835 7.0782
.261 Weber 9.4167

107. 2.0294
5.5076
.00394 7.5470
1 9.4167
75.8 1.8797

300 2.4771
7.0782
.359 9.5553

180 2.2553
5.5076
.00558 7.7629
1 9.5553
62 1.7924

9 Ohms + in line

On C	56 L		215
	55 R		111
	111		326
On A	106 R		215
	109 L		221
	215		436
			218
11-15 On B	57 L		110
	53 R		111
	110		221
On B	54 R		
	55 L		
	109		

6 Ohms + in line

On B	90 L	
	90 R	
	180	180
		120
On C	60 L	300
	60 R	
	120	
11-26 On A	152 R	
	148	
	300	

448 2.6513
7.0752
Weber .536 9.7265
380 2.4482
5.8976
7.9548
100901 9.9955
1 1.7747
59.5

583 2.7657
Webers .698 7.8782
380 9.8939
2.8911
.01125 5.0515
6.9426
1 9.9439
55.6 1.7952

402 2.6042
183 2.2853
219 3186
502 2.7534
402 2.6042
1,04 1532

85 2.1615
85 comp 3075 7.5122
170 170 2.2304
comp .0017 9.9930
Webers .544 9.7356

.572 2.7574
comp .545 0.2644
comp .228 10.6424
3-6639

105Z to one Weber
3.0218

Ohmst 00,4610. = 1 Volt on A

4 Ohms + in line

On A	2202	402	402
	222R	455	455
	442	897	897
		948	948
On B	145R	402	402
	141 Z	167	167
	286	225	225
		560	560
On C	80R	280	280
	87 Z	266	266
	167	167	167
		455	455

2 Ohms + in line

On C	88R	193	193
	85 Z	402	402
	193	595	595
		376	376
On A	283 Z	283	283
	288R	289	289
	290R	572	572
		595	595
		1167	1167
		568	568
On B	205R	402	402
	197 Z	328	328
	402	768	768
		390	390

around 1 Ohm + Temp 79°

3 Ohms in
852
85R
770

	219	2.34041
Amt		10.7944
1 Weber	320	2.5048
		10.65515
1 Volt	1430	3.1563
	8.3	.91971
Weber	111.900	4.07754
	256	2.40882
comp	320	7.54752
.180 Webers		9.95634
	184	2.26448
comp	11900	5.92746
	.0154	8.18894
		7.99274
1		1.71140
517		1

184	2.26448	256 2.40882
72	1.85773	184 2.26455
2.55	.40675	139 .14434

June 11 '27

2000 Ohms in shunt

3 Ohms in line compare with last

On A 110 R 219
109 R

2 1/2 Ohms in in line

On A 128 R 129 R
128 R 126 R
256 255

on B 92 R
92 R
184

on C Temp 77° 184
37 R 72
35 R 256
72

3.02.5 2.4807
7.4952
Helen .946 9.9759
2:2 2.3483
5.9246
.0187 8.2729
9.9759
1.7030
1/60.4

388 2.5888
7.4952
1.21 .0840
304 2.4829
5.9246
.0255 8.4075
.0840
1.6765
1/47.5

June 11

2 Ohms + in line

On C 40 R
39 L
40 R
79

On B 115 L
116 R
231

79
231
300

302.5

C 155 R
150 L
305

1 1/2 Ohms +

On A 192 L
198 R
390

386

B 150 L
152 R
302

C 42 L
42 R
84
302
386

530 2724
7.4953
Weber 1.6550 .2495

432 2 635
5.92.46
8.56.01
.2195
1.6494

10363
1
44.6

1 Ohm +

2 mm " 131

on C
50 R
48 L
98

on B
220 R
214 L
434

434
98
532
53

on A
262 L
266 R
528
530

5 turns W on 1 Ohm +

235 R
200 L

Zero 18 R

June 1 13

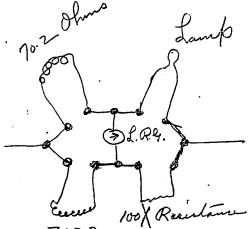
On 1 Ohm in ~~box~~ multiple

185 R
173 L
358

10 ohm in box

180 R
168 L
348

Lamps in bridge June 11 '3



7020 100 X Resistance of Lamp

Less risk, to take

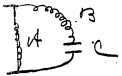
14040 200 X Resistance of Lamp

1500
1500
2400
6300
12600 in W.U. Box

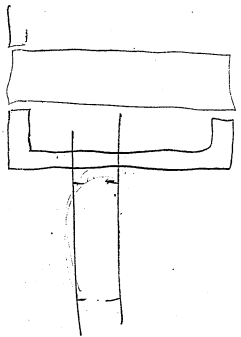
14040
12640
1400

12220 Ohms in B.A Box

12640
6320
6240



Mesh

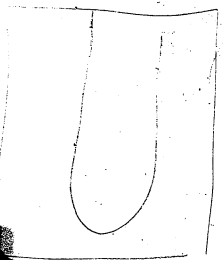


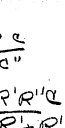
$R'' = \frac{R\,C}{C''}$ $\quad C'' = \frac{R\,C}{R''}$

$C'' = \frac{R'R''C}{R'+R''} \times \frac{1}{R''} = \frac{R'}{R'+R''}\,C$

$C' = \frac{R''}{R'+R''}\,C$

$\frac{A}{A+X}\,C$





$B + C = X$

$A -$

Current through B

Total resist = ...

$C_m = C_m' + C_m''$

$\frac{1}{R} = \frac{1}{R'} + \frac{1}{R''} = \frac{R'+R''}{R'R''}$

$R = \frac{R'R''}{R'+R''}$

$\frac{1}{R'} : \frac{1}{R''} :: C' : C''$ $\quad \frac{\frac{1}{R'}}{\frac{1}{R''}} = \frac{C'}{C''}$

$\frac{1}{R'} + \frac{1}{R''} : \frac{1}{R''} :: C' + C'' : C''$

$:: C : C''$

$\frac{1}{R} : \frac{1}{R''}$

$R'' : R :: C : C''$

$R' : R :: C : C'$

$\frac{\mathcal{E}}{14+x}$ Q

$\frac{\mathcal{E}-\mathcal{E}'}{R}$ = current

$\mathcal{E}' = f(\mathcal{E}R)$

~~$\mathcal{E}' = f(\mathcal{E}R)$~~

The contrary E.M.F. depends on the E.M.F. at the extremities of the line and the resistance in the line

However you get the E.M.F. E.M.F.

E.M.F.

$\frac{33000}{8} = W$ $R = 100$

$W = \frac{\mathcal{E}^2}{R}$ $443 = \frac{C^2}{100} 44.3$

$\frac{33000}{8} = C^2 44.3$

$\frac{33000}{8 \times 44.3} = C^2$

2.51855
8.35536
9.09969
9.96990

.931 Webers

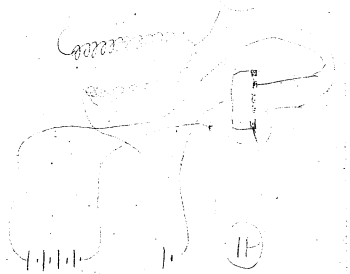
.0310
1.0730 Ohms in shunt to give volt

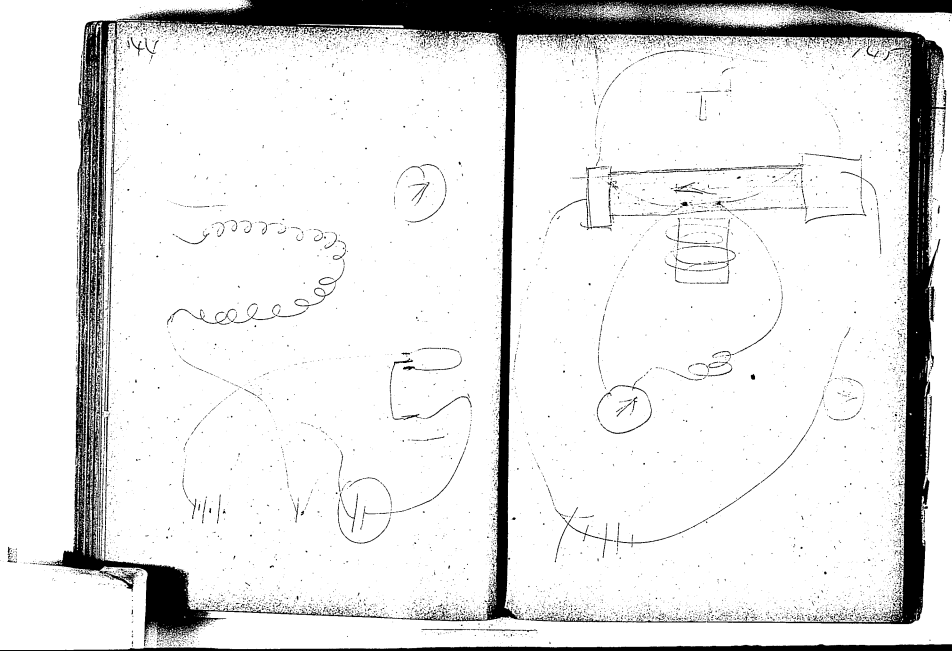
Can afford to lose 1% on meter 100 Ohm lamps
5 lamps 20. Ohms
.020 Ohm in shunt

143

Spacing 9 known

$\mathcal{E}$ constant
R Variable
$\mathcal{E}$





$$\frac{\vartheta_5}{qr-ps} = \frac{\vartheta}{(r+p+q)(q+s+q)-q^2}$$

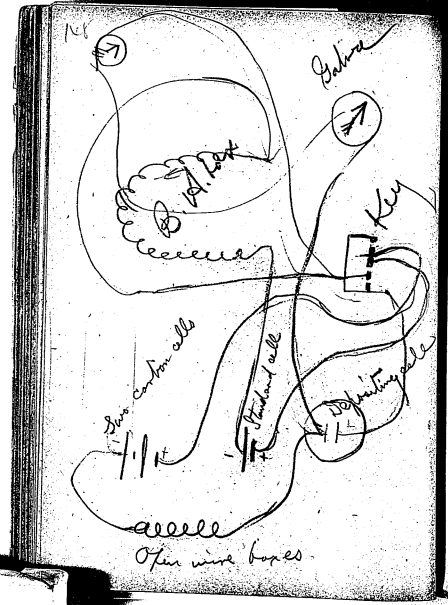
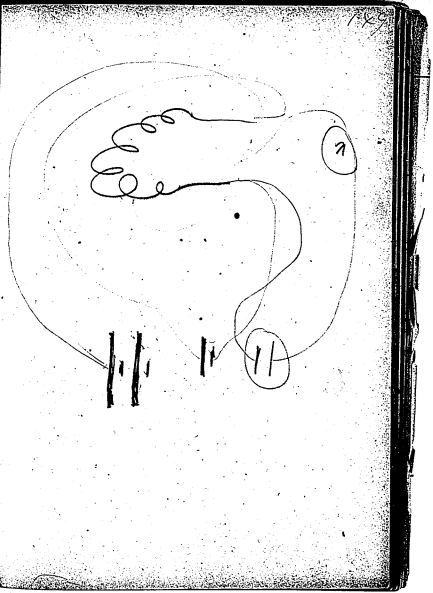
$$\frac{\vartheta_5}{\vartheta} = \frac{qr-ps}{(r+p+q)(q+s+q)-q^2}$$

q and r at pleasure

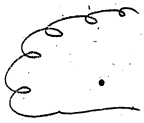
$\vartheta = \infty$ will fullfill this

or

$\vartheta_5 = 0$.


Galvo
Key
Two cadmium cells
Standard cell
Reversing pole
Other mine boxes


170



163)800 (4.9 ct
652
1480

151

190 mg 2 clamps Pump

18 air mg

190)29000 (152.
190
1000
950
500
380
1200
1140
600
570
30

152)5.00 (5.1 ml
760
400

190)31103 (163.
990
1210
1140
703

192

1.08
1.6
6 48
10 8
17.28
5
86.40

17.2
3
51.6

17.28 Volts

10
730+15 Daniells polarization

Daniells Thumbstop 270 = 2

15
270 on cell

27
270 on cell

½ Volt from wrought iron new magnet

5 | 335
67 Volts

3 | 210 Strong field
70 Volts

Small wrought iron Motor 155
235 Main current Speed 1620 r.p.m.
47 around magnet
Ratio main to magnet

47/235 16 cells 0·2

~~5 Volts~~ armature 10·2
~~3 ½ Volts~~

Main line Bank 32 to 78 lags

Magnet	Volts	Armature Volts
47/235 of 62	4.12	34 10·2
97	6.47	42.3 12·7
115	7.61	47.3 14·2
131	8.73	50.6 15·2
162	10.8	56.3 16·9
178	11.9	59.6 17·9
226	15.2	67.6 19·0

Volts

116 280 18.6 67 201 67.

16 cells 31 Volts 216 72.

on line 280 31 Volts

16 cells 52 R

Very strong 7 222 74.

280	2.4472
Comp 31	8.5086
p. 152 17.28	1.2370
	2.1928
	8.8239
	1.0167
Eq 3	0.4771
	1.4938

20 Volts

400	26020
44.3	1.6464
6.8	9.1675
	3.4159

2600 ft. lbs. on magnet to saturate

4	51 85
3.41	5-9
	.0026

12.7 magnets per H.P.

Cu. Cell

10 / 730+15 polarization

Daniells 272 = D

30 / 272 on cell

10-30 145 / 272 on cell

10 / 350+15 polarization

10-35 72 / 272 Daniells on cell

10 / 615 polarization after current had passed a long time through

160

16 cccc = 5 / def
Defon Line 95

80
66
14
8

1·1461 (2)
2·2922

1·8195 (2)
3·6390
2·2922
1·3468

22.2 (2)
44.4

65.5
14.5
548

1·8182 (2)
1·1614
1·3096

204 (2)
40.8

161

80
64.75
1525

1·1832 (2)
23664

1·8112 (2)
3·6224
2·3664
1·2560

18 (2)
36

7 165

2/10

No 1145

Lamps 163 Ohms cold
very high the same

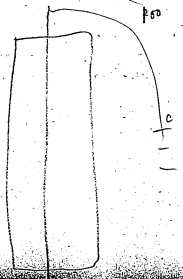
No. 1164

180 Ohms Cold

Busted

168 Ohms cold

169 "



June 22 1880

Running free

928
2
1856

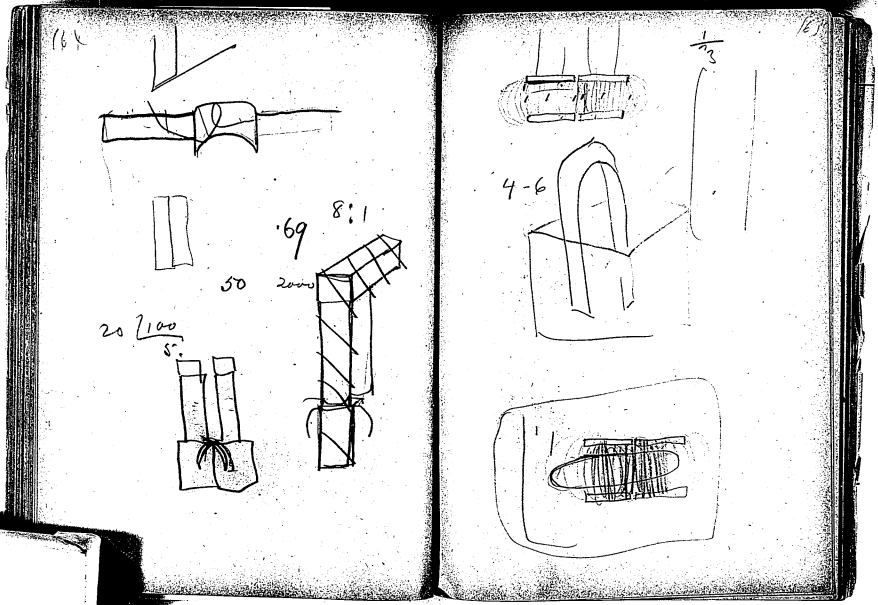
825
799

2 lbs 1.4 oz at 4 feet

810
12
1620
810
9720
2

3 × 4

About 19,440. ft. lbs.


16
.69
8:1
50
20
100
4-6

Meter Shunt No. 4

June 22 1880

20 cells 108 = D

~~around~~ 8,8 Ohms

100 = D

~~75~~ Galva. current same
magnet way
up shunt open.

78 R
79 L

on Shunt No 4

On 4.01 Ohms with cell

57 L
55 R

On cell deposition

25 L
24 R

168

167

On Shunt No. 4

80 R

80 L

Made 19 on Shunt No. 4

126 L

133 R

126 L

On 4.01 Ohm

96 L

101 R

~~On Shunt~~

165 L

180 R

On 4.01 Ohms

131 L

142 R

170.

16	4.
8.	
128	2.1072
257	2.4099
	4.5171

32,900

1.6532
.7404
2.3936

247 candles per H.P.

Small Bent fibre 171

102 Volts

Two lamps in series

	6296
	6296
	2000
	800
	15880
	76.9

102	2.0086
102	2.0086
	1.6464
77	8.1135
	3.7771
5980	4.5185
	.7414

5,5 per H.P.

45 candle	3.7771
	1.6532
	2.1239

133 ft lbs per candle

172

Small bent fibre lamps

4144 ft lbs

83.9 Ohms

88.6 Volts.

22 candles from two lamps in series

88000 / 120 = 2.1293 — 45185 / 2.0792 = 15 candles per H.P

273 ft. lbs. for candle

4144 / 22 = 188 ft. lbs per candle

3.6174 + 1.3424 = 4.5185

4.5185 − 3.6174 = .901

7.9 per H.P

Small test fixture Carbide
2½ hours at 58.5 standard
candles from two one minute
brighter than the other.

104 ft. lbs. for candle

65.5 1.8162
14.5 1.1642
6520
2
1.3040

20.
2
40

66.5 1.8228
13.5 1.1303
.6925
2
1.3850

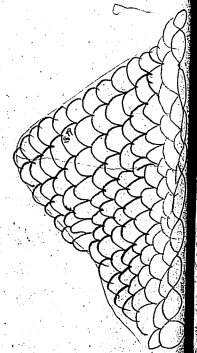
24.3
2
48.6 candles
16.2
64.8 candles
48.6 1/3 More than
9.7 standard candles
58.5

176

Jablochkoff

400) 33000

82.5 ft. lbs. per candle



177

102	2.0086
102	2.0086
	1.4464
75.4	81.1226
6110	3.7862
58.5	1.7672
	2.0196

.104 ft. lbs. per candle

15080

7540

.5185

560

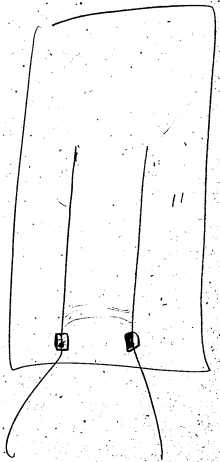
4 . 5185
3 . 7862
.7323

3.4 per H.P.

.7323
1.7672
2.4995

316 candles for H.P.

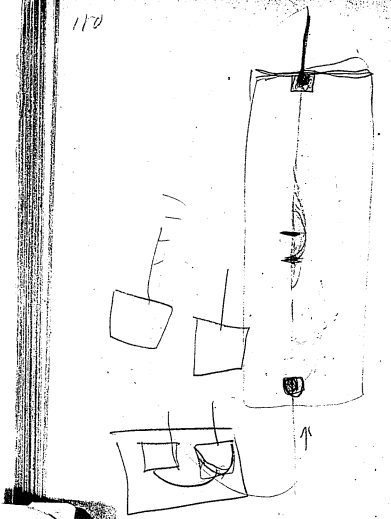
5 hours 10 minutes
7 hours 10 minutes



2 cells
94 L
93 R
192 R
195 L

6½ candles

6280
1000
650



Small Bait Fibre

9 candles

9.4
93
18.7

9.35	.9708
1.08	.0334
8.66	.9374

9 candles

			Ohms
207	L		500
205	R		100
412		2.6149	62.50
		.9374	7780
47.6 Volts		1.6775	3890
		1.6775	
		1.6464	
Ohms 38.9		8.4101	
		3.4115	

2580 ft lbs
285 ft lbs. per candle

112

8 candles

203 R

5-5-0

4052.6075 38.4 Ohms
.9374
1.6701
1.6701
1.6464
38.4 8.4157
3.4023

~~1500~~
2520

113

June 23 1880

Test small wrought iron motor 80 Volt on armature 12 Ohms in line with magnet

2 lbs 14 oz weight at 5 feet circumference

1060 revs per min

5650 · Speed of Prony Shaft

2

1130 r.p.m.

15

5650

1130

16950 ft lbs

156 The Rowing gave a great deal of trouble

30 443
20 3987 ft.
900

at 4 feet

613
2
1226 r.p.m.

at ~~6 feet~~
509
2
1018

~~at 8 feet~~

1018
18
8144
1018
Abt 8,324 ft. lbs.

Small test fibre
half length

Tungsten vil lamps 8 ~~Shunt~~
2-3 22 cp candle standard Candles
Started
3 170
56.6 Volts

6290
1000
200 | 7290
36.45 Ohms

22 candles standard
170
2-24 stopped for ~~next~~ Tantor
2-57 6290 Started
800
7090

Test of 2-24

9 | 7018 — 30 20 — 900

257
224
33

57
40
97 | 9
33
64 minute

50 50 25 25 | 216 | 8 | 20.6 | 4

56.6 1.7528
56.6 1.7528
1.1464
8.4389
3900. 3.5909
4.5180
8.46 for H.P. .9276
3.5909
1.3624
2.2585
180 ft lbs per candle

4-35 Reversal poles
stopped about one minute
started at 5.50

5.50
2 3
347
34
3h13m

Gave light for 3 hours
and thirteen minutes
22 candles

3 hours 13 minutes

192

4

2

1155

13225

403

105

5 105

5600

6250

2117

1178

170

5522/6 = 920 r 2

920 r 2

311

193

No 1177

Put on at 6.35 a.m. started C. 40 ohms while hot

Def 196. basted at 6.50

Camp No 1179

Def 205 45 ohms hot

22 C put mat 6.55.

basted at 7.3

Camp No 1159

Def 345 C.P. ~~450~~ 37.4 Candles

105 ohms hot put on at 7.10

5322 ft lbs basted at 9.5

4/5522

138.

7.10

1.55 m

5522 3.7419
37.5 1.5740
2.1679

147 ft. lbs per candle

3 | 196
65.3

1.8149
1.8149
1.6464
compass 8.3979

4720 3.6741
1.3424
2.3317

215 ft lbs per candle

at 58 candles both lamps
104 ft. lbs. per candle
at 22 candles one lamp in globe
180 ft. lbs. per candle
at 22 candles small lamp in Tube
215 ft. lbs per candle

65 1.8129
15 1.1761
.6368
2
1.2736

18.7
2
37.4 candles

Large fibre No 1168

Kerosene oil lamp
= 8 candles

9-52 Made large d2 X.9 12
4" long bark fibre
No. 1168
44 candles

348 H.R 3 ± 1 Volt
116 Volts
6290
6290 1258.0
3800
16380
81.9 Ohms 16

10-8 345
115

200

348 : 355 :: 81.9 : X

2.5502
1.9133
7.4584 4.4635
1.9219

83.5
81.9
1.6 Two 3 Ohm boys in multiple arc

19
7
9
35 minutes

Large test fibre 201
No 1168

116
118 2.0645
2.0645
1.6464
81.9 8.0867
3.8621
7280 ft lbs.

3.8621
3.6435
.2186

165 ft. lbs. per candle

10-11 Stopped to change
10-57 Started
11-44 Stopped
11-55 Started

11-44
35 minutes

Large bent fibre
0".012 X 0".012 No. 1167

Kerosene oil lamp
8 candles +
Screen at 11 candle mark

10-15 Lamp 40 candles
curled mark Mahogany
44 candles
352 = Ω on H R
1173
82.4 Ohms

2.0688
2.0688
1.6469
8.084.140 | 7380
3.8681 | 1844

5
7
10

22 minutes to 11-27
35
57 minutes

12 580
4450
17030
851

57
15
72

118 2.0719
2.0719
851 1.6464
8.0797
3.8609
7206 44 1.6435
1.2174

164 ft. Wis. per candle

Batt No. 1167

10-20 Stopped to change
10-57 Started 48 candles
11-4 Stopped Resume to Lunch
11-15 Started
350 I+R
48 candles
11-25 Stopped
11-27 started 44 candles
12-2 Stopped
355 = D 3 = 1 Volt
118 Volts
After 10 P.M
15 minutes Jehl
72 minutes

342 : 355 :: 79.8 : X

1.9020
2.5502
9.4660
1.9382

86.7
79.8
6.9 2 boxes in series

Boat barge No. 1158

Slightly irregular

Bright 20 million H.R. 6 ft 6 ft

10-30 Started

342 H.R.
114
12580
3380
1596 0
79.8 / 114

2.0569
2.0569
1.6464
8.0980
3.8582
1.6435
2.21 ft

7220

16 # ft. lbs. per cu. ft.

208

209

Bank No 11548

10-34 Stopped to change

1057 Started

50 Banked

H Stopped

Candle power before this 48-50 as the kerosene lamp had increased its pressure by heating

11 minutes

Results

	Lt lbs per candle
Two small lamps one very high	10 4
105 Ohm Lamp & Watt giving 37.5 candles	147 Jehl
Large bast fibre at 44 candles	164
Small bast fibre in globe at 22 candles	180
Small bast fibre in tube at 22 candles	215
Small bast fibre in globe 9 candles	285

213

Lamps - June 24

Small test 22 candles

- more than 22 candles

Large fibre 1158

1168

1167

Large fibre Flamingo

Time burned 24

3 hours 13 minutes

2 hrs 30 ——

9 ——

35

1. hour 12 ——

22 ——

24

13.6 — 1.1335
13.6 — 1.1335
1.2469
Comp 69.9 — 8.1551
2.0685

11.7 ft. lbs.

43.3 — 1.6365
1.6365
1.6464
52.95 — 8.2761
3.1955
15.70 — .6021
3.5934

392 ft. lbs. per candle

48.3 — 1.6839
1.6836
1.6964
51.45 — 8.2886
3.3028
6.5 — .8129
2.4899

309 ft. lbs. per candle

June 24-25-26

Bast fibre 0.012 V 0.012 — 0.024 R 27.3

New candles

20 cell 65 L
65 R
21.6

Temp 85° F

Red
6290
7700
13990
69.95

2220

3 | 41 = N — 3 = 1 Volt
13.6

6290
4500
10790 ohms — 4 candles
5 3.95
130 = D
433

6 1/2 candles

145 = N = 4.83 Volts
6299 = 51.45 ohms
4000
10.290

1.7269
1.7269
50.4 ct 1.6464
8.2971
3.3973
12 1.0792
2.3181

208 ft. lbs. per candle

5.03 1.7016 afternoon
1.7016
1.6464
8.2971
2220 3.3467
.1903
2.4436

277

Evening page 279

259 ft. lbs

Small bast fibre

12 candles

1160 = Ω
5-3.3 Volts
6290
3800 Ohms
10090
5-0.45

8 candles
1511 = Ω
5-0.3
6290
3800 Ohms
10090
5-0.45

1.7016
1.7016
1.6464
8.3037
3.3533
1.0792
2.2741

225.0
12

188 ft lbs per candle

56.6 1.7528
1.7528
1.6464
47.7 8.3215
3.4735
19.2 1.2833
2.1902

155 ft. lbs per candle

160 = D
50.3

12 candles
6290
3650 Ohms
19940
49.7

170 = D
56.6

19 1/2 candles
19 candles
6290
3250 Ohms
19540
47.7

1.7619
1.7619
1.6464
46.7 8.3307
3.5007
1.3424
2.1575 143 ft. Ms

1.7582
1.7582
1.6464
8.3497
3.5125
1.3522
2.1603 144 ft. Ms

Small boat Inne 24

2-35 22 candles

173.5 = D
57.8
6290
2050 Ohms
9340
46.7

~~22~~ 5 candles

3-5 2650 Ohms in box
172 ÷ D L
173 = D R 57.3

2650
6290
8940
44.7

Candles

1143
1143
2286

New foreigner

3-6 Lighted
24 candles
22.5 candles

3-13 Stopped

224

1.7101
1.7101
1.6464
64.95 8.1875
2260 3.3541
1.5 0.1761
3.1780

1500 ft. lbs per candle

53.6 1.7528
1.7528
1.6464
62.45 8.2045
3.3565
2270 0.4771
2.8794

757 ft. lbs. per candle

227

Small boat fibre in tube No. 1182

3-17

$\frac{115.4}{51.3} = D$

6290
6700
12990 6495

1 1/2 Candle

3 candles

$\frac{170}{56.6} = D$

6290
62.00 Ohm
12480
6245

1.7993
1.7993
1.6464
8.2299

3.4749 2980

7.5 .8751

2.5998

399 ft. lbs to one candle

69.6 1.8426
1.8426
1.6464
54.9 8.2604

3.5920
13 1.1139

2.4781

301 ft. lbs

2-25 189 189 63 Volts.

7½ candles

6290
5500
790
58.9

200 198 199 198

13 candles

6290
4700
1590
54.9

1.8488
1.8488
1.6464
8.2848
3.6288
1.3010
2.9278

212 candles per candle

Same 24.8025

Std candle from 1182 tube

212 = 0

212 - 70.6

20 candles

6290
4100
10390
51.9

2 30

1,8751
1,8751
1,6464
87.9 8.0560
13.4526
4771
2.9755

945 ft. lbs. per candle

1.9410
1.9410
1,6464
84.6 8.0726
3.6010
.9031
2.6979

499 ft. lbs. per candle

Lamp 1187 23
Large test combined with Humidity

6290
6290
5000
17580
87.9
3 candles

225 = N
75 Volts

8 candles

1262 = N
87.3 Ohms

4350
6290
6290
16930
84.65 Ohms

2.0025
2.0025
1.6464
78.1 8.1073
22 8.6576
2.4163

26.2 ft. lbs. per candle

115 2.0607
2.0607
7.6464
69.4 8.1580
3.9264
8440 1.6435
2 2829

192 ft. lbs. per candle

Lamp 1187

302 = D
100.6

22 candles

6290
6290
3050
15630
78.15

3-40 44 candles 66 inches

~~3=40~~
345 = D
115

6290
6290
1300
13590
6940

2092
1626
1466
233
116 grains

Lamp 1187

3-51 blew out candles

blue at lamp

4 stopped for George

1049
1043.5 3/4 hour
20921.5

2286.
193.5 4/6 = 1 candle
4
6|774.0
129. grains an hour

4-5 started

4-7 22 minutes

6-6 stopped

1.8235
1.8235
1.6464
99.1 8039
52973

1960 ft. lbs. per candle

Regular test No. 1181

4-7 Candles lighted

1 Candles

200 = N
66.6

6258
6290
6290
1080
19830
99.15

1.9345
1.9345
1.6464
8.0297
9.3010
2.8461

702 ft. lbs per candle

2.0253
2.0253
1.6464
8.0635
16 8.7959
2.5564

360 ft. lbs per candle

M 1181

~~28~~
86.
5 candles

6100
6290
6298
18680
93.4

16 candles

6290
6290
4700
17280
86.4
1302 ≈ D
100.6

240

2.0645
2.0645
1.6464
8.1158
8.3565
2.2477

176 ft. lbs per candle

No. 1181 June 24

44 candles

352

10 minutes Very high one

275 ft lbs

350 R
360 L
116

2750
6290
6290
15330
7666

2.0492
2.0492
1.6464
8.1085
8.3565
2.2098

162 ft. lbs per candle

1185

335
112
2900 Ohms
44 candles
5 minutes
Slipped out of clamp

2900
6290
6290
15580
779

2,0471
2.0471
1.6464
8.1018
8.3565
2.1989

158 ft. lbs per candle

large boat
W 1153 with partition

337
1116
3250 Ohm
6290
6290
15830
7915

44 candles

5 minutes

1.9850
1.9850
1.6464
8.0752
8.7959
2.4875

307 ft. lbs. per candle

1153 with Lantern

16 candles

2908
96.6

4250
6290
6290
16830
84.15

2.0386
2.0386
1.6464
8.9742
8.7959
2.4937

311 ft. lbs per candle

No 1191 Good lamps

328 = 10 on H.R
109.3
16 candles

8650
6290
6290
21230
106.15 Ohms

2.0194
2.0194
1.6464
8.0026
8.7959
24837

304 ft. lbs per candle

Lamp No. 1183

16 candles
very good at dull red

321 N.R

21230

16 candles

314
104.6

8290
6290
7360
19880
9940

206

afternoon

2.0472
2.0473
1.6464
8.8976
8.7959
2.4345

271 ft. lbs per candle

Evening

2.0607
2.0607
1.6464
8.8962
8.7959
2.4599

288 ft. lbs per candle

207

Lamp No 1190

16 candles

(335 = D
1 11.6

afternoon
345
115

6250
6290
6290
6500
25370
126.85 Ohms

6250
6290
6290
6650
25480
127.4

Evening

345

260

1186

261

Good custom

16 candles

292

947.3

62 50
6290
6290
100

19930

$99.65

1189

16 candles

319 N.R
106.3

950
6250
6290
1290
19580
97.9

Afternoon

1.9699
1.9699
1.6464
8.0724
8.7959
2.4535

284 ft lbs per candle

Evening

1.9805
1.9805
1.6464
8.0788
8.7959
2.4841

305 ft lbs per candle

No 1166

16 candles

280 = D
93.3

287 = D
95.6

4350
6290
6290
16930
84.65

4100
6290
6290
16680
83.40

afternoon

2.0294
2.0294
1.6464
8.0070
8.7959
2.5081

322 ft. lbs per candle

Evening

2.0414
2.0414
1.6464
8.0127
8.7959
2.5377

345 ft. lbs per candle

New Batteries next day

1.9474
1.9474
1.6464
8.0320
8.7959 3.5736 234 ft. lbs per candle
2.3691

DVC

No 1180

16 candles

321	330
107	110
1050	600
6290	6290
6290	6290
6250	6250
19680	2 19430
98.40	97.15

1265
84.6

6290
6290
6000
18590
929 Ohms
Ohms

No. 1180

3.5736

3740 ft. lbs.

4.5155
3.5736
.9447

8.8 per H.P.

16
1.4
64
15
224

2½ lbs 6 (13.4 / 2.2)

11.2 cts

From Book 48 End

Coal taken at $3 per ton

July 29 2240 lbs

3 X 5 = 15 — $2.50 — 3.0969 — 1.1761 — 4.2730

18700 / 2240 = 8.36 tons — 3.3502 — .9228 — .4771 — 3 — 1.3999

$24 — 187.5 — 2.2729 — 9.1270

3 lbs 13.4 cts per M for coal

Stoking $4.00 per day

4 — 2.6021 — 2.2729 — 3292

2.1 ct for stoking

Water for boilers

Estimated at 1/3 coal ~~labor~~

Summer 4 cts per M

Rent $5.000 per year

5.000 5.6990

4.8293

.8697

7.4 cts per M

9

Summary 6 per H. P.

Depreciation	7.3
Taxes	3.7
Labor	6.9
Coal	13.4
Stoking	2.1
Water	4.
Insurance, Rent &	7.4
	44.8

44.8 cts at station

3 lbs per hour

2½ lbs per hour 42.6 cts

at consumers 46.9 cts

Mains 44.7

1.6767
1.6767
1.6464
8.3170
9.0969
2.4137

25-9 ft. lbs

Ex

Small boat

8 candles

143 = D
47.6

3350
6290
9640
48.20

$6\frac{7.5}{7} : 100 :: 16 :$

$7\frac{1}{1600}$

23.

Executive 2 cts per M

4 cts per M

Say 50 cts per M cost at consumer

Old Paper

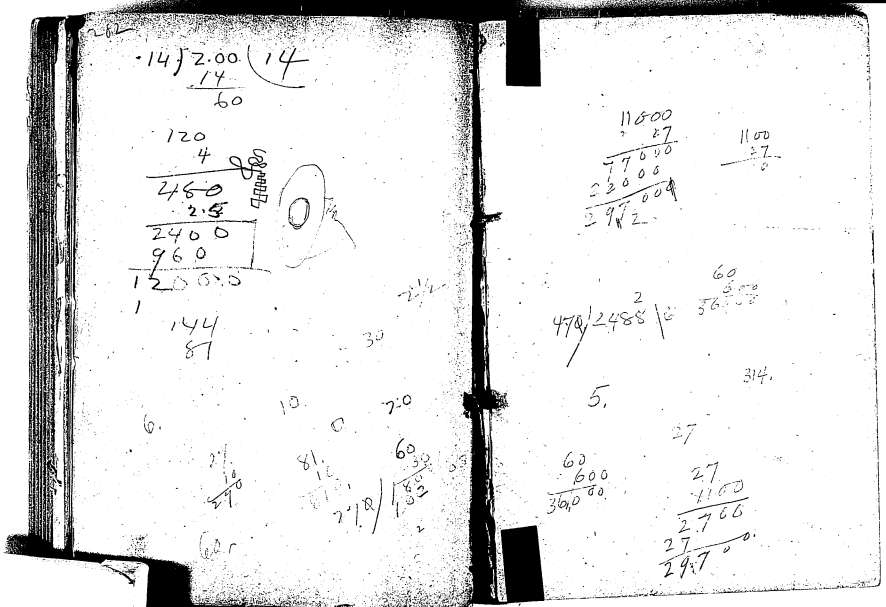
Dividends at 1.00 per M

125 000 invested

675 00 M annually made

$33.750 profit

About 33⅓ dividends

$1.50 per M

66⅔ dividends